

U.S. Patent Application Serial No. 10/030,126
Amendment filed February 22, 2005
Reply to OA dated November 23, 2004

AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1 Claim 1 (currently amended): An in-mold coating formation method, wherein a mold is
2 opened at a predetermined interval after a thermoplastic resin material is subjected to an injection-
3 molding within a mold, a predetermined amount of coating material is injected into a space formed
4 between the surface of the thermoplastic resin molded product and the internal surface of the mold
5 cavity of the mold by using a coating material injection device, the mold is reclosed upon the
6 completion of injection of the coating material, the injected coating material is allowed to cure
7 within the mold so as to obtain an integrally formed molded product having a coating layer tightly
8 adhered to the surface of the thermoplastic resin molded product, characterized in that:

9 (1) injection of a coating material is performed only after a time period has passed which is
10 necessary for the surface of the thermoplastic resin molded product to be cured to such an extent that
11 said surface can withstand an injection pressure of the coating material and a flowing pressure of said
12 coating material;

13 (2) an injection time of the coating material is set to be within a range of 0.10 t_1 to 0.99 t_1 ,
14 when a gel time of the coating material in contact with an internal surface of the mold is defined as

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15 t_1 ; and

16 (3) a time period from beginning of injection of the coating material to its spreading through
17 an interior of the mold by reclosure of the mold is set to be within a range of 0.20 t_1 to 1.10 t_1
18 wherein t_1 has the same meaning as defined above, wherein

19 the injection of the coating material is started at a time when said thermoplastic resin arrives
20 at a temperature equal to or lower than its thermally deforming temperature in the case that said
21 thermoplastic resin is an amorphous resin, and

22 the injection of the coating material is started at a time when said thermoplastic resin arrives
23 at a temperature equal to or lower than its crystallizing temperature in the case that said
24 thermoplastic resin is a crystalline resin.

Claim 2 (canceled).

1 Claim 3 (withdrawn): An in-mold coating formation method, wherein the mold is opened
2 to at a predetermined interval after a thermoplastic resin material is subjected to injection-molding
3 within a mold, a predetermined amount of a coating material injected into a space formed between
4 surface of a thermoplastic resin molded product and internal surface of a mold cavity of a mold by
5 using a coating material injection
6 device, the mold is reclosed upon the completion of injection of the coating material, the injected
7 coating material is allowed to cure within the mold so as to obtain an integrally formed molded

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8 product having a coating layer tightly adhered to the surface of the thermoplastic resin molded
9 product, characterized in that:

10 a stroke of a hydraulic cylinder for providing a driving force to close a mold in a toggle type
11 injection molding machine, or a stroke of a ball screw for providing a driving force to close a mold
12 in a toggle type electric injection molding machine, is subjected to a feedback control which is
13 performed by using a mold closing servo valve or a servo motor, thereby effecting a drive control
14 using a preset mold opening amount changing pattern and a preset mold closing force changing
15 pattern.

1 Claim 4 (withdrawn): An in-mold coating formation method according to claim 3, wherein
2 an in-mold pressure of the coating material injected in the mold is subjected to a feedback control
3 which is performed by using a mold closing servo valve or a servo motor, thereby effecting a drive
4 control using a preset changing pattern.

1 Claim 5 (withdrawn): An in-mold coating formation apparatus, wherein the mold is opened
2 to at a predetermined interval after a thermoplastic resin material is subjected to injection-molding
3 within a mold, a predetermined amount of coating material injected into a space formed between the
4 surface of the thermoplastic resin molded product and the internal surface of the mold cavity of the
5 mold by using a coating material injection
6 device, the mold is reclosed upon the completion of injection of the coating material, the injected

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7 coating material is allowed to cure within the mold so as to obtain an integrally formed molded
8 product having a coating layer tightly adhered to the surface of the thermoplastic resin molded
9 product, characterized in that the apparatus comprises:

10 a mold closing servo valve for controlling a flow rate and a pressure of a working oil being
11 supplied to a mold closing hydraulic cylinder in a toggle type injection molding machine; a stroke
12 sensor for detecting the stroke of the hydraulic cylinder; a mold opening amount sensor for detecting
13 the mold opening amount of the mold; a mold closing force sensor for detecting a mold closing force
14 of the mold; a coating material pressure sensor for detecting an in-mold pressure of the coating
15 material injected in the mold; a coating material injection device for injecting the coating material;
16 a mold closing condition setting section for setting and inputting the mold's mold opening
17 amount changing pattern and its mold closing force changing pattern, and the coating material's in-
18 mold pressure changing pattern;

19 injection device control section for receiving a command signal fed from the mold closing
20 condition setting section so as to drive and control the coating material injection device;

21 a changing pattern storing section capable of storing a correlation between a stroke of the
22 hydraulic cylinder detected by the stroke sensor and a mold opening amount detected by the mold
23 opening amount sensor, and another correlation between a stroke of the hydraulic cylinder detected
24 by the stroke sensor and a mold closing force detected by the mold closing force sensor, also capable
25 of converting a mold opening amount changing pattern and a mold closing force changing pattern
26 both of which have been set in advance in the mold closing condition setting section into stroke

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27 changing patterns of respective hydraulic cylinders;
28 a mold closing control section which is provided to cause the mold closing servo valve to
29 perform a feedback control in accordance with a stroke changing pattern of the hydraulic cylinder
30 and an in-mold pressure changing pattern of the coating material.

1 Claim 6 (withdrawn): An in-mold coating formation apparatus according to claim 5, wherein
2 the toggle type injection molding machine is replaced by a toggle type electric injection molding
3 machine, the mold closing hydraulic cylinder is replaced by a mold closing ball screw, the mold
4 closing servo valve is replaced by a servo motor.

1 Claim 7 (withdrawn): An in-mold coating formation mold which is equipped with a coating
2 material injection device for injecting a coating material into a mold cavity in order that a coating
3 layer can be formed on the surface of a thermoplastic resin molded product within the mold,
4 characterized in that:

5 an auxiliary cavity extending in the opening and closing direction of the mold is formed
6 which is communicated with the mold cavity of the mold through the entire circumference thereof,
7 the auxiliary cavity has a thickness of 0.1 to 2 mm and a length of 0.5 to 30 mm.

1 Claim 8 (withdrawn): An in-mold coating formation mold according to claim 7, wherein
2 there is provided a heater for heating a cavity surface of the auxiliary cavity, said cavity surface being

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3 on the coating material injection side.

1 Claim 9 (withdrawn): An in-mold coating formation method, wherein an in-mold coating
2 formation mold is used which is equipped with a coating material injection device that is provided
3 for injecting a coating material into a mold cavity in order that a coating layer can be formed on the
4 surface of a thermoplastic resin molded product formed by virtue of the mold, and which is also
5 equipped with an auxiliary cavity communicated with the mold cavity of the mold through the entire
6 circumference thereof, characterized in that:

7 an auxiliary molded body is formed by a resin to be used for molding injected into the
8 auxiliary cavity, a small gap is formed because of a small shrinkage of the auxiliary molded body
9 so that the small gap is located between the auxiliary molded body and the internal surface of the
10 auxiliary cavity, said gap being used in preventing the coating material from flowing out of the mold.

1 Claim 10 (withdrawn): An in-mold coating formation method according to claim 9, wherein
2 the temperature of the cavity surface on the coating material injection side of the auxiliary cavity is
3 kept higher than other parts of the mold, the coating material spread from the mold cavity surface
4 is cured in the auxiliary cavity, thereby preventing the coating material from flowing out of the mold.

1 Claim 11 (withdrawn): An in-mold coating formation method, wherein the mold is opened
2 at a predetermined interval after a thermoplastic resin material is subjected to injection-molding

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3 within a mold, a predetermined amount of coating material is injected into a space formed between
4 the surface of the thermoplastic resin molded product and the internal surface of the mold cavity of
5 the mold by using a coating material injection device, the mold is reclosed upon the completion of
6 injection of the coating material, the injected coating material is allowed to cure within the mold so
7 as to obtain an integrally formed molded product having a coating layer tightly adhered to the surface
8 of the thermoplastic resin molded product, characterized in that:

9 after the mold is opened at a predetermined interval after a thermoplastic resin material is
10 subjected to injection-molding within a mold, a predetermined amount of coating material is injected
11 into a space formed between the surface of the thermoplastic resin molded product and the internal
12 surface of the mold cavity of the mold by using a coating material injection device, the mold is then
13 closed upon the completion of injection of the coating material;

14 an in-mold pressure of the coating material is controlled such that said pressure will arrive
15 at a predetermined value of 0.5 MPa or higher in a zone where the thermoplastic resin molded
16 product receives the lowest pressure within the mold.

1 Claim 12 (withdrawn): An in-mold coating formation method according to claim 11,
2 wherein a sub-cavity is formed which is communicated with the mold cavity, a groove portion is
3 formed which is communicated with the sub-cavity.

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1 Claim 13 (withdrawn): An in-mold coating formation method, wherein the mold is opened
2 at a predetermined interval after a thermoplastic resin material is subjected to injection-molding
3 within a mold, a predetermined amount of coating material is injected into a space formed between
4 the surface of the thermoplastic resin molded product and the internal surface of the mold cavity of
5 the mold by using a coating material injection device, the mold is reclosed upon the completion of
6 injection of the coating material, the injected coating material is allowed to cure within the mold so
7 as to obtain an integrally formed molded product having a coating layer tightly adhered to the surface
8 of the thermoplastic resin molded product, characterized in that:

9 when the surface of the thermoplastic resin molded product has been cured, the mold is
10 opened at a predetermined interval, a heat diffusion from surface of a thermoplastic resin molded
11 product to one mold portion is prohibited, after surface temperature of the thermoplastic resin
12 molded product has been increased to a value which is equal to or higher than a curing temperature
13 of the coating material because of a heat held within the thermoplastic resin molded product, the
14 coating material is injected.

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